Design project discussion

Aerospace Systems ▷ ENGN4339 ▷ Week 2

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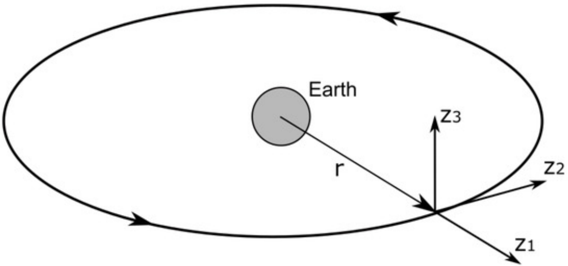
- Requirements, guidelines and assessment criteria are provided in the *Wattle* document.
- We will go through the technical background of this project.
- We will further discuss particular sections of the project that might be challenging.

We briefly discussed about docking from a technical standards perspective in Lecture 1B.

From a functionality perspective:

- Docking: Proximity maneuver and attachment to the ISS.
  - ▷ Dragon, Soyuz, Progress, Space Shuttle
- Berthing: Capture and attachment to ISS by a robotic arm.
  - ▷ Cygnus, HTV, Dragon, ATV

Understanding the Clohessy-Wiltshire frame of reference.



On the performance index.

- The integral.
- The inner product.

$$J = \frac{1}{2} \int_{t_i}^{t_f} U^T U \, dt$$

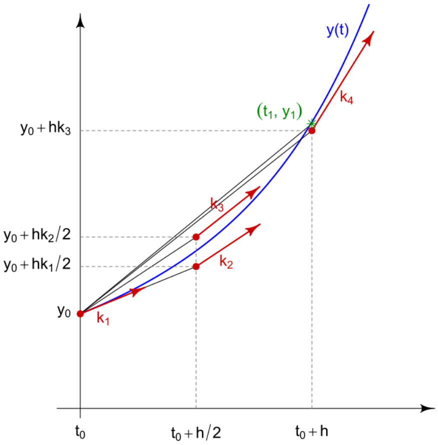
Consider an initial value problem.

$$\dot{y} = f(y, t), \;\; y(t_0) = y_0$$

Solution by classic Runge-Kutta method.

$$y_{n+1} = y_n + \frac{h}{6}(k_1 + 2k_2 + 2k_3 + k_4)$$
$$k_1 = f(t_n, y_n)$$
$$k_2 = f(t_n + \frac{h}{2}, y_n + h\frac{k_1}{2})$$
$$k_3 = f(t_n + \frac{h}{2}, y_n + h\frac{k_2}{2})$$
$$k_4 = f(t_n + h, y_n + hk_3)$$

Numerical propagation

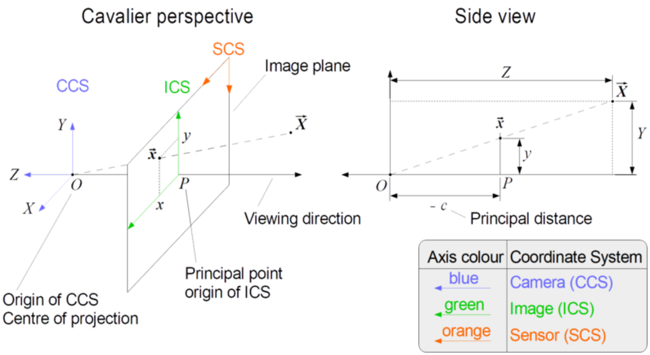


State-space representation.

$$\dot{x} = Ax + Bu, \;\; x(t_0) = x_0$$

How do we represent our design problem in this format?

How to model a pinhole camera?



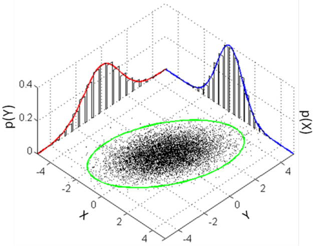
$$[\textit{Image coordinates}] = [\textit{Intrinsic matrix}] \times [\textit{Extrinsic matrix}] \times [\textit{World coordinates}]$$

- World coordinates: **Position** of the ISS in CW frame.
- Extrinsic matrix: **Transforms** ISS to camera coordinate frame.
- Intrinsic matrix: **Projects** image using camera parameters.

How do we simulate noisy sensor measurements?

Measured value = True value + Sensor noise

Sensor noise $\rightarrow$ Sample a Gaussian distribution of mean 0 and variance σ^2.



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